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Characteristics of Extreme Auroral Charging Events

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The highest level spacecraft charging observed in low Earth orbit (LEO) occurs when spacecraft are exposed to energetic auroral electrons. Since auroral charging has been identified as a mechanism responsible for on-orbit anomalies and even possible satellite failures it is important to consider extreme auroral charging events as design and test environments for spacecraft to be used in high inclination LEO orbits. This paper will report on studies of extreme auroral charging events using data from the SSJ/4 and SSJ/5 precipitating electron and ion sensors on the Defense Meteorology Satellite Program (DMSP) satellites. Early studies of DMSP charging to negative potentials ≥100 V focused on statistics of the electron environment responsible for charging. Later statistical studies of auroral charging have generally focused on solar cycle dependence of charging behavior and magnitude of the maximum potential and duration of the charging events. We extend these studies to focus on more detailed investigations of extreme charging event characteristics that are required to evaluate potential threats to spacecraft systems. A collection of example auroral charging events is assembled from the DMSP data set using the criteria that "extreme auroral charging" is defined as periods with spacecraft negative potentials ≥400 V. Specific characteristics to be treated include (but are not limited to) maximum and mean potentials, time history of spacecraft potentials through the events, total charging duration and the time potentials exceed voltage thresholds, frame charging/discharging rates, and information on geographic and geomagnetic latitudes at which the events are observed. Finally, we will comment on the implications of these studies for potential auroral charging risks to the International Space Station.